

ILLICIUM GUAJAIBONENSE, ELEVATED TO SPECIES RANK AND COMPARED WITH THE SUBSPECIES OF *ILLICIUM CUBENSE* (ILLICIACEAE)

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ABSTRACT

Illicium cubense subsp. *guajaibonense* has been re-collected on the slopes of Pan de Guajaibón, Pinar del Río, Cuba. The smooth epidermal cells of the petioles and stems of these plants and their red flowers with usually obovate to lingulate inner tepals, which are recurved-spreading, support the recognition of this entity as a distinct species, ***Illicium guajaibonense***, and a new combination is provided. The newly recognized species is also provided with an expanded description and compared to the geographically isolated populations of *I. cubense*.

RESUMEN

Illicium cubense subsp. *guajaibonense* ha sido re-encontrada en las vertientes de Pan de Guajaibón, Pinar del Río, Cuba. Las células epidérmicas lisas de los pecíolos y de los tallos de estas plantas, junto a sus flores rojas con tépalos internos generalmente obovados a lingulados, los cuales son recurvados-extendidos, apoyan el reconocimiento de esta entidad como una especie distinta, ***Illicium guajaibonense***, por lo que se propone una nueva combinación. Se provee una descripción ampliada para la especie aquí reconocida y se compara con las poblaciones geográficamente aisladas de *I. cubense*.

KEY WORDS: *Illicium*, Illiciaceae, Cuba, Pinar del Río

In the course of fieldwork in the province of Pinar del Río in western Cuba the second author collected a distinctive species of *Illicium* sect. *Cymbostemon* (see Morris et al. 2007) on the slopes of Pan de Guajaibón, on the western edge of the Sierra del Rosario. Subsequent study of these specimens (along with herbarium material of *Illicium cubense* A.C. Smith occurring in both western and eastern Cuba, as well as *I. ekmanii* A.C. Smith, *I. floridanum* J. Ellis, *I. hottense* Guerrero, Judd & A.B. Morris, and *I. parviflorum* Michx. ex Vent., all of which belong to sect. *Cymbostemon*) have led to the realization that these Pan de Guajaibón plants, which had been described as a subspecies of *Illicium cubense* (Imkhanitskaya 1993; i.e., *I. cubense* subsp. *guajaibonense*), are better understood as a distinct species. Thus, we propose here the new combination *Illicium guajaibonense* for this distinctive Pinar del Río entity.

Illicium cubense, a Cuban endemic, was considered by Imkhanitskaya (1993) to be widely distributed on the island, and she grouped its rather variable populations into five subspecies. Our observations (based on 29 collections, excluding duplicates) suggest that these four subspecies, in addition to *I. cubense* subsp. *guajaibonense*, have consistent morphological differences (among many other polymorphic features) that correlate with their geographical distributions, and they are thus easily diagnosed. As discussed in more detail below, we found the epidermal features of the petiole and young stem to be especially useful in diagnosing these entities (although distinctive floral features also occur in subsp. *guajaibonense*). Of these subspecies, *I. cubense* subsp. *rangelense* Imkhanitskaya, like subsp. *guajaibonense*, is restricted to western Cuba,

where it is restricted to the Sierra del Rosario, near Rangel. *Illicium cubense* subsp. *cubense*, subsp. *bissei* Imkhanitskaya, and subsp. *guantanamense* Imkhanitskaya are endemic to the mountains of eastern Cuba, with subsp. *cubense* occurring in the Sierra Maestra, including the Gran Piedra range (southern “Oriente”), subsp. *bissei* occurring in the Sierra de Nipe, Sierra de Cristal, Cuchillas de Moa, Sierra Mina de Iberia, Cuchillas de Toa, and Cuchillas de Baracoa (all in northern “Oriente”), and subsp. *guantanamense* occurring in the Sierra de Purial, Sierra de Imías, and the Meseta del Guaso (prov. Guantánamo).

Taxonomic reconsideration of the status of these remaining subspecies of *Illicium cubense* must await field investigations and the study of additional specimens (especially of material in Cuban institutions) of the taxonomically difficult eastern Cuban entities (subsp. *bissei*, subsp. *cubense*, and subsp. *guantanamense*) as well as the western Cuban taxon, *I. cubense* subsp. *rangelense*. The latter is especially poorly collected, and field studies of all of these entities would also be of value in working out the systematics of these plants (and such studies are currently underway; Alejandro Palmarola B., personal communication). Thus, we restrict our current focus to *I. guajaibonense*, since for this Pinar del Rio endemic we have adequate material to understand its pattern of variation. Our additional collections (and especially the field observations of J.R.A.) allow *I. guajaibonense* to be described in more detail than previously has been possible, and it is now readily distinguished from the various entities provisionally retained within *I. cubense*. We thus provide a full description and a new combination below, along with a discussion of morphological features that distinguish this new species from *I. cubense*. Finally, we note that our preliminary studies suggest that all of the subspecies of *I. cubense* may be better treated at the species level, and these subspecies are briefly compared.

In the following description we have based measurements on leaves that are presumably fully expanded, avoiding leaves at the apex of shoots if they are smaller than nearby leaves; we note that young leaves often dry a different color than adult leaves. The measurements of both vegetative and floral parts are based on dried herbarium material.

Illicium guajaibonense (Imkhanitskaya) Judd & Abbott, comb. et stat. nov. (**Fig. 1**). *Illicium cubense* A.C. Smith subsp. *guajaibonense* Imkhanitskaya, Bot. Zhur. 78:2. 1993. TYPE: CUBA. PROV. PINAR DEL RIO: northern slopes of Pan de Guajaibón, 16 May 1953, Bro. Alain & J. Acuña 2972 (HOLOTYPE: HAC, n.v.; ISOTYPE: GH).

Shrub to ca. 2 m tall; bark grayish brown, slightly fissured; young stems brownish to grayish, 1.6–2.7 mm in diameter near the lowest leaves, $\pm$ terete to obscurely angled, with decurrent ridge below some nodes, the surface smooth (although lightly to heavily wrinkled on drying) with rectangular epidermal cells that are neither papillate nor bullate. *Petiole* (0.7–)1.1–1.3 mm in diameter near middle, slightly wider and swollen at point of attachment to stem, narrowing to midrib, but difficult to delimit because blade often slightly decurrent onto petiole, drying dark (blackish), 4–10 mm long, excluding apical portion with obvious laminal flange, although there are often slight ridges on either side of the petiole adaxially, smooth, at least when fresh, wrinkled on drying, the epidermal cells neither bullate nor papillate, sometimes arranged in transverse rows; leaf blade thinly coriaceous, somewhat crisply succulent when fresh, and not particularly tough or fibrous, fragmenting readily when dry, light green abaxially when fresh but reddish brown when dried, dark green adaxially when fresh, more or less shiny (due to waxy cuticle) but dull grayish brown with pale greenish tinge when dried, generally $\pm$ elliptic to elliptic-obovate, occasionally ovate (the widest point mostly at or above the middle, sometimes parallel sided for about 10 mm near mid-leaf), 3.4–9.5 cm long, 1.4–4.2 cm wide, the base acute to cuneate, forming a 25–45° angle, often with a small flange of decurrent tissue along the upper petiole, the apex mostly $\pm$ acute, sometimes obtuse and bluntly rounded, forming a 30–45(–70)° angle, rarely with a small emarginate indentation; margin minutely revolute, either uniform throughout or the revolute portion slightly wider at base and narrowing toward apex, sometimes the extreme apex with margin plane; midvein shallowly sunken above, becoming more or less flush with the blade near the apex, when dried often inconspicuous for the apical 4–15 mm, slightly darker than blade, strongly raised below, very rounded near base, becoming flattened and less distinct towards apex, although usually clearly visible all the way to the tip, concolorous with blade to much darker, with epidermal cells nearly isodiametric near base, ranging to rectangular and then very elongate towards mid-leaf and apex, the secondary veins



FIG. 1. *Illicium guajaibonense*, on slopes of Pan de Guajaibón, Cuba (Abbott 18885).

obscure (not visible on many leaves), but at least a few leaves with 2–5 visible secondary veins per side (but generally only a small portion of the proximal part of the vein visible), loosely looping together near the margin (i.e., brochidodromous) and with irregularly developed and only poorly visible tertiary veins (but these only seen with transmitted light), with spicy sweet, non-anise fragrance when crushed. *Flowers* axillary, but inflorescences distally clustered on branches and thus appearing terminal, with 1–4 inflorescences per stem, although apparently only one at a time with open flowers, the flowers 1–3 per cluster; subtending bracts (in tight cluster at base of pedicel) (3–)4–5, rounded ovate, sometimes broadly so, ca. 0.5 × 0.8 mm, the margin ciliate to nearly entire, persistent through anthesis, but perhaps deciduous in fruit. *Pedicels* slender, ca. 0.7 mm wide near middle, sometimes nearly the same width from base to apex, but usually widest at base and narrowing to apex, 6–11 mm long at anthesis, nearly straight to recurved, flexuous; with 0–3 bracteoles, usually 1 or 2 of these near pedicel base and 1 near apex, broadly rounded-ovate, but curved around pedicel and sometimes appearing ± triangular in side view, 0.6–1 × 1–1.2 mm, the margin ciliate. *Perianth segments* (tepals) 12–16, the 3–5 outermost tepals similar to large bracteoles, greenish (when fresh), broadly rounded-ovate to somewhat bluntly triangular, 1.2–1.8 mm long, 1.7–2.5 mm wide, with margin ciliate, the next 5–8 tepals much larger, 4.5–7.6 mm long, 2.5–4.1 mm wide, red (or the outermost ones red and mottled with green or pale brown), non-papillose, obovate to lingulate to sometimes slightly unguiculate (i.e., somewhat clawed at base, with narrow, pinched-in portion above extreme base), recurved-spreading, weakly concave to convex adaxially, with margin ciliate (outermost) to entire (innermost), and 2 or 3 of this set often cupped near the upper margins, the innermost 3–5 tepals grading into the stamens in size (and 1 or 2 may even be stamen-like, with non-functional thecae), same

color and shape as larger tepals, although none cupped or ciliate margined; generally the outermost greenish tepals persist after the reddish, petaloid tepals and stamens have fallen, the surface of the tepals mostly smooth except for drying-related wrinkles, with glandular idioblasts apparent as lighter punctations. *Stamens* 5–7, uniseriate, except for 1 or 2 that are sometimes intermediate with tepals, 3.3–3.7 mm long, 1–1.7 mm wide, carnose (i.e., thicker and fleshier than the tepals when fresh, although not apparently so when dried), red, the filaments laminar, the anthers poorly developed, with thecae introrse, sub-immersed in the connective tissue, ca. 0.8 mm long, narrowing to a truncate apex. *Carpels* 7–8 in a single, tight, ring-like whorl, 2.5–3 mm long, the ovary laterally compressed, curving inwards above; style 0.8–1.2 mm long, erect to curved-spreading. *Fruits and seeds* not known.

Distribution and ecology.—*Illicium guajaibonense* is endemic to Pinar del Rio, Cuba, where it has been collected on the slopes of Pan de Guajaibón (at the western edge of the Sierra del Rosario) at 500–600 m elevation, and at Loma Español, San Cristobal. At the Pan de Guajaibón locality the species occurs on bauxitic soil in mesophyllous evergreen forest with *Adiantum* spp., *Blechnum fragile* (Liebm.) C.V. Morton & Lellinger, *Buchenavia tetraphylla* (Aublet) R.A. Howard, *Brysonima* sp., *Calophyllum antillanum* Britton, *Citharexylum* sp., *Cyathea arborea* (L.) Sm., *Cyrilla* sp., *Daphnopsis* sp., *Dendropanax arboreus* (L.) Decne. & Planch., *Lagetta wrightiana* Krug & Urb., *Matayba apetala* Radlk., *Mecranium haemanthum* Triana ex Cogn., *Miconia prasina* (Sw.) DC., *Ocotea leucoxylon* (Sw.) Laness., *Odontosoria* sp., *Ouratea elliptica* (A. Rich.) M. Gómez, *Pachyanthus tetramerus* Urb. & Ekman, *Polystichum wrightii* (Baker) C. Christensen ex Maxon, *Pseudolmedia* sp., *Sagraea capillaris* DC., *Selaginella* spp., *Talipariti elatum* (Sw.) Fryxell, *Ternstroemia* sp., and *Trichomanes scandens* L.

Phenology.—Flowering material has been collected in May and July.

Additional collections. **CUBA. Pinar del Rio Prov.**: Pan de Guajaibón, western edge of Sierra del Rosario, on the northern slopes near old military barracks a little below the summit, 500–600 m, between 22°47'17"N, 83°22'5.8"W and 22°47'23.6"N, 83°21'59.5"W (WGS 84 map datum), 8 May 2004 (fl) Abbott 18885, with Bécquer (FLAS, HAJB, NY, S, US); Loma Español, San Cristobal, 6 Jul, 1860–1864 (fl) Wright 1844 (GH).

DISCUSSION

Illicium guajaibonense belongs in the *I. parviflorum* complex, within *Illicium* sect. *Cymbostemon* (as recircumscribed by Morris et al. 2007) because its stamens have conspicuously thickened filaments and sub-immersed anther thecae. We note that the monophyly of this clade is also supported by molecular data (Morris et al. 2007). Vegetatively, it can be distinguished from the various entities retained within *I. cubense* subsp. *cubense*, subsp. *bissei*, and subsp. *rangelense* by the smooth epidermis of its petioles (vs. microbullate, micropapillate, or tuberculate-papillate; Fig. 2), smooth epidermis of its young stems (vs. micropapillate to tuberculate-papillate, rarely microbullate or nearly smooth), and only shortly and apically flanged petioles (vs. petioles with flange of lamina tissue extending to near base); see Table 1 for a more detailed comparison of these taxa. The flowers of *Illicium guajaibonense* have red, obovate to lingulate inner tepals, which are recurved-spreading and adaxially weakly concave to convex, and stamens narrowed to a truncate apex (Fig. 1), while those of *I. cubense* subsp. *cubense* and subsp. *bissei* (Fig. 3) have yellowish green, suborbicular to elliptic or ovate, adaxially concave, non-recurved tepals, and stamens abruptly narrowed to a differentiated, obtuse-rounded apex. The stamens of *I. guajaibonense* are red while those of *I. cubense* subsp. *bissei* are peach-orange with the apical portion purple-tinged; stamen color has not been recorded in subsp. *cubense*. The flowers of *I. cubense* subsp. *rangelense* are poorly known, but the tepals of this taxon are broadly ovate to elongate-elliptic, oblong, or obovate, and also somewhat spreading, and the stamens are narrowed to a truncate apex. Thus, the flowers of subsp. *rangelense* may be more similar to those of *I. guajaibonense* than to the populations of *I. cubense* from eastern Cuba; unfortunately, the color of the tepals and stamens is unknown in subsp. *rangelense*, and observations of living flowers are required in order to accurately record tepal shape/curvature.

Illicium guajaibonense can be distinguished from the poorly known *I. cubense* subsp. *guantanamense* by its red (vs. yellowish green) flowers; we have not compared the vegetative characters of *I. guajaibonense* with *I. cubense* subsp. *guantanamense* as we have not seen herbarium material of this rarely collected taxon.

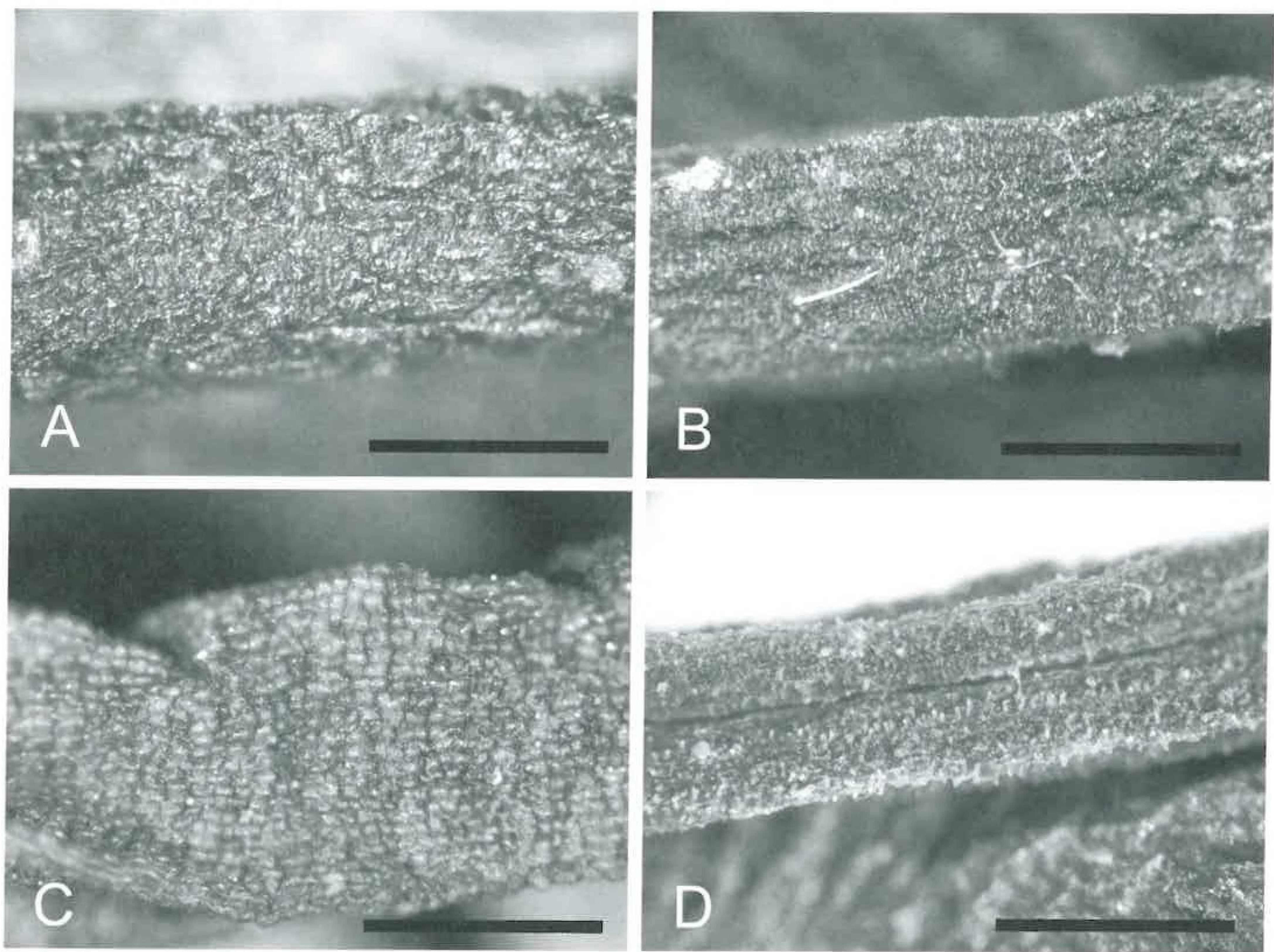


FIG. 2. Variation in form of epidermal cells of the petiole. A. *I. guajaibonense* (smooth; Abbott 18885, FLAS). B. *I. cubense* subsp. *cubense* (micropapillate; Bro. Clemente 6477, GH). C. *I. cubense* subsp. *bissei* (microbullate; Bro. Alain & Figueiras 4536, GH). D. *I. cubense* subsp. *rangelense* (tuberculate-papillate; Bro. Alain 536, GH). Black bar = 1 mm.



FIG. 3. *Illicium cubense* subsp. *bissei*, from the Alto de la Torre, Sierra de Nipe, Prov. de Holguín, Cuba (Abbott 18953).

TABLE 1. Morphological characters best distinguishing the Cuban taxa of *Illicium*. *Illicium cubense* subsp. *guantanamense* not included (due to lack of available material).

Taxon	<i>I. cubense</i> subsp. <i>bissei</i>	<i>I. cubense</i> subsp. <i>cubense</i>	<i>I. guajaibonense</i>	<i>I. cubense</i> subsp. <i>rangelense</i>
Petiole flange	to near base	to near base	only short, apical flange	to near base
Petiole texture	microbullate (Fig. 2C)	micropapillate (Fig. 2B)	smooth (Fig. 2A)	tuberculate-papillate (Fig. 2D)
Stem texture	micropapillate (rarely microbullate near nodes)	micropapillate (to nearly smooth)	smooth	tuberculate- papillate (some narrow, sharp-pointed)
Young stem (dried condition)	micro-ridges	micro-ridges	wrinkled (smooth when fresh)	micro-ridges
Stem epidermal cells	isodiametric	isodiametric to elongate	isodiametric to rectangular	elongate
Leaf margin	revolute (blade sometimes also cupped)	revolute (blade flat)	revolute (blade flat)	revolute (blade mostly flat, sometimes slightly cupped)
Secondary veins abaxially	obscure (mostly not visible except on some specimens with wide shade leaves)	obscure (mostly not visible)	generally visible, especially on largest leaves	obscure to sometimes visible
Flower color; Inner tepal shape	yellowish green; sub-orbicular to, ovate or elliptic and non-recurved	yellowish green; sub-orbicular to ovate or elliptic, and non-recurved	red; obovate to lingulate, and recurved-spreading	color not recorded; ovate to elongate- elliptic, oblong, or obovate, and spreading

Illicium cubense primarily occurs in the mountains of eastern Cuba, but subsp. *rangelense*, like *I. guajaibonense*, is endemic to western Cuba. *Illicium cubense* subsp. *rangelense* is phenetically distinctive due to its tuberculate-papillate stems and petioles, and on some plants the papillae are even narrowed and sharply pointed apically, looking like minute hairs (Fig. 2D). Additionally, the flowers of subsp. *rangelense*, as noted above, are quite different from those of the eastern populations of *I. cubense*. Thus, *I. cubense* subsp. *rangelense*, like *I. guajaibonense*, is easily distinguished from the other *Illicium* populations of Cuba. Were subsp. *rangelense* better known, we also would have proposed raising it to specific rank, as both seem to be amply distinct from each other, as well as from the populations of *I. cubense* from eastern Cuba. Unfortunately, it has been poorly collected, and (as noted above) the flower color is unknown. The status of subsp. *rangelense* is currently being investigated by A. Palmarola B. (as part of his revisionary study of *Illicium* in Cuba).

Illicium guajaibonense can be distinguished from *Illicium parviflorum* (of peninsular Florida; see Guerrero 1997) by its nearly unflanged (vs. ± flanged) petioles, leaves with a spicy, sweet (vs. anise) fragrance, differently shaped, red (vs. pale yellow) inner tepals, and 7–8 (vs. 10–13) carpels. It can be differentiated easily from *I. floridanum* and *I. mexicanum* (both continental in distribution) because these two species have more numerous and much more elongated tepals, as well as more numerous carpels. Finally, it is also differentiated from the two Hispaniolan species, *I. ekmanii* and *I. hottense* (Guerrero et al. 2004) by its nearly

unflanged (vs. $\pm$ flanged) petioles, and differently shaped, red tepals (vs. pale yellowish to pink or red tinged in *I. ekmanii*; yellowish, tinged basally with salmon-color or yellowish with peach margins in *I. hottense*). In addition *I. hottense* has outer tepals that are strongly papillate, i.e., the entire surface of the tepals is densely papillate. The perianth segments of *I. ekmanii* lack papillae or are only very slightly papillate, i.e., with sparse papillae in the central region of the tepals and not extending to margins. The tepals of *I. guajaibonense* are consistently non-papillate. The petioles of *I. ekmanii* are smooth or with sparse low papillae; those of *I. hottense* are smooth, with a few scattered bumps, or rarely microbullate.

Phylogenetic analyses using ITS, *trnL*, *trnL-F*, and *trnG* sequence data (Morris et al. 2007) support the monophyly of the New World species of *Illicium*, i.e., section *Cymbostemon*, as re-circumscribed. Within this clade, *I. floridanum* and *I. mexicanum* are sister to a clade containing (among sampled taxa) *I. parviflorum*, *I. hottense*, *I. ekmanii*, *I. cubense* subsp. *bissei*, and *I. guajaibonense*, i.e., the *I. parviflorum* complex. These two clades, in addition to being well-supported by molecular characters (Bayesian posterior probabilities of 1.00 and 0.98, respectively), reflect very different floral morphologies (Imkhanitskaya 1993; Guerrero 1997), although we note that lingulate tepals have evolved independently in *I. guajaibonense* and in the common ancestor of the *I. floridanum* + *I. mexicana* clade. Within the *I. parviflorum* complex, molecular resolution is lacking due to short branch lengths, with each species exhibiting one to six autapomorphic DNA characters. This pattern is consistent with the differences among closely related species observed within the Old World clade (Morris et al. 2007), indicating that such differences provide additional support for species recognition. Furthermore, short branch lengths within the New World clade, relative to long branch lengths between the New and Old World clades, indicate recent speciation within this group, and suggest the possibility of a history of extinctions within *Illicium*.

Red flowers are undoubtedly autapomorphic for *Illicium guajaibonense*, and this morphological feature, along with the molecular autapomorphies indicated in Morris et al. (2007), indicate that it probably is, therefore, a cladospecies, satisfying the requirement of the apomorphy species concept (Donoghue 1985; Mishler & Theirot 2000; Judd et al. 2008). It is evident that *I. guajaibonense* also satisfies the morphological-phenetic (Judd 2007) and diagnostic (Wheeler & Platnick 2000) species concepts.

Although *Illicium guajaibonense* and *I. cubense* (with its various subspecies) are probably each other's closest relatives, as evidenced by the reduced number of carpels (Guerrero 1997), we believe that it is probable that *I. guajaibonense* represents a distinct evolutionary lineage (see de Queiroz 2007), which would be obscured by considering these Pan de Guajaibón plants within a broadly circumscribed *I. cubense*. The rank of subspecies has been used in various ways, but could be interpreted to imply that the boundaries between *I. guajaibonense* and the various entities within *I. cubense* are not entirely fixed. However, as we have shown, this is not the case for *I. guajaibonense*, which is amply and consistently distinct from the various entities within *I. cubensis* in both vegetative and reproductive characters. It is our view that the rank of subspecies should be used for geographical or ecological variants with demonstrable intergradation.

Illicium guajaibonense, which may now be limited to a small forested region on the Pan de Guajaibón, should be considered as "critically endangered" according to the guidelines of the IUCN red data book categories (Lucas & Synge 1978). The very small population should be protected from development.

Pending a detailed monographic study of New World *Illicium*, the following preliminary key (with treatment of *I. guantanamoense*, for which we have not seen specimens, based on characters reported by Imkhanitskaya, 1993) is provided as an aid to the identification of the species and subspecies of *Illicium* occurring in Cuba.

1. Petioles and stems conspicuously tuberculate-papillate (i.e., with elongate, rounded to sharp projections from the epidermal cells; Fig. 2D; generally tightly packed but with scattered flat, smooth spots where the epidermal cells can be seen), with some papillae narrow and hair-like; plants of western Cuba (mountains near Rangel) _____ ***I. cubense* subsp. *rangelense***
1. Petioles and stems microbullate, micropapillate, or smooth (apart from wrinkling related to drying), but never tuberculate-papillose.

2. Flowers with inner tepals bright red, obovate to lingulate, and recurved-spreading; petioles and young stems smooth (apart from wrinkling related to drying; Fig. 2A); plants of western Cuba (Pan de Guajaibón) _____ **I. guajaibonense**
2. Flowers with inner tepals yellowish green, suborbicular to elliptic or ovate, and non-recurved; petioles and young stems microbullate, micropapillate, or smooth (apart from wrinkling related to drying); plants of eastern Cuba.
3. Petioles $\pm$ smooth; plants of prov. Guantánamo _____ **I. cubense** subsp. **guantanamense**
3. Petioles microbullate or micropapillae; plants of eastern Cuba, prov. Granma, Holguín, Santiago de Cuba, and northern Guantánamo (Cuchillas de Baracoa).
4. Petioles microbullate (i.e., swollen ends of nearly isodiametric epidermal cells producing continuous rows of low, rounded, regular, tightly packed, squarish protuberances; Fig. 2C); young stems micropapillate (sometimes microbullate near nodes); petiole flange usually to very base; leaves usually somewhat abaxially curved (to more or less flat in shade); plants of northern "Oriente" _____ **I. cubense** subsp. **bissei**
4. Petioles micropapillate (i.e., small, rounded projections from the epidermal cells, with tiny, flat, smooth regions between the papillae; Fig. 2B); young stems micropapillate to sometimes $\pm$ smooth; petiole flange usually ends 1–2 mm above petiole base (usually with raised ridge lines continuing to base); leaves always $\pm$ flat; plants of southern "Oriente" _____ **I. cubense** subsp. **cubense**

ACKNOWLEDGMENTS

We thank Norris Williams, Keeper of the University of Florida Herbarium (FLAS) in the Florida Museum of Natural History, and Kent Perkins, Collections Manager, for assistance in processing specimens. We also thank Emily Wood, senior collections associate of the collections of the Harvard University Herbaria for the loan of their Cuban *Illicium*. We thank Eldis Bécquer G. for his assistance to J.R.A. during his field work in Cuba and Alejandro Palmarola B. for comments on an early version of this paper. We thank Steven Manchester for his assistance in the production of Fig. 2 and Lorena Endara for assistance with the Spanish abstract.

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